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Developments of N. Kh. Arutyunyan ideas in contemporary mechanics
The influence of Academician Arutyunyan ideas on contemporary mechanics and the
development of his ideas in modern science are under consideration. Three main areas of Solid
Mechanics are studied in details. They are viscoelasticity, contact mechanics, and mechanics of
growing solids. The development of the theory of viscoelasticity is closely connected with ideas
of aging and inhomogeneous aging. New directions in contact mechanics are defined by
concepts of multi-body non-simultaneous contact and discrete accretion. Mechanics of growing
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These areas have numerous intersections and generate new problems which are of great
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About stability of rectangular plate and circular ring

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Shape memory alloys: rheonomic properties and stability

Experimental data is described following which shape memory alloys (SMA) have rheonomic properties. Two model of rheonomic behavior of SMA are proposed. Question about the influence of rheonomic properties on stability the simplest parts containing SMA is investigated.

Selected problems of nanomechanics

In the study of nanoscale objects is necessary to consider the growing influence of the surface. A number of classical problems of elasticity for nanoscale structures, taking into account surface stresses, are considered. The results of analysis are compared with classical results. The effect of taking into account surface stresses on the effective stiffness of nanoporous rod and the stability of a plate with a circular cut in tension is investigated.

The results of investigations of protected deformed properties of layer damping elements of antiseismic foundation

The analysis of results of the investigation of protracted deformed processes subject to ageing of materials allows to make a conclusion on the possibility of the use of these elements for the solution of engineering problems. Therefore in the capacity of criteria estimation of construction the insignificant influence of protracted compression may be accepted on the behavior of multi-layer rubber cushions reinforced by plates.

On contact between an infinite stringer and an elastic semi-infinite plate with a vertical crack

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On hydraulic calculation of the established filtration of the liquid in the porous multilayered ground

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Distinctive features of the shearing stream flows and their mathematical models

In work the peculiarities of the water flows in the lengthy bed-stream are discussed as well as approaches to deriving their mathematical models. The specific model equations that describe bed-stream flow as 3D phenomenon are under consideration but they are more simple then general hydrodynamic equations. In contrast to the averaged equations, these reduced models are taking into account the stream cross-structure that allows us to study the effects of the river-bed and river-banks shapes as well as some surface phenomena like the wind action.
Multidisciplinary model of borehole environment for description of physical fields of different nature

A 3D model describing the hydrodynamical and geomechanical fields’ evolution under deep borehole drilling was designed. The zones of irreversible deformation may occur in the vicinity of borehole at definite relation between rock strength properties, drilling mud pressure and magnitude of virgin horizontal stresses. These zones influence considerably on borehole surveying apparatus readings that has to be taken into account in coarse of log data interpretation.

Strained-deformed state of two rugged under the corner of lines in field of gravity force

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A contact problem for a composite plate with two different semi-infinite stringers

In the present paper a contact problem is considered for an elastic composite (piecewise-homogeneous) infinite plate, consisting of two semi-infinite plates with different elastic properties, that are attached to each other along the common straight border, and strengthened with two different semi-infinite elastic stringers with different rectangular cross-section, which are parallel to the mentioned plate’s heterogeneity line and are at the same line. The considered contact problem is formulated as a singular integral equation with kernel, consisting of singular and regular parts. By means of Fourier generalized integral real transform the integral equation is reduced to a functional equation with respect to the Fourier transformants of unknown functions of intensities of tangential contact forces and deformation of intermediate finite segment between the stringers. Then, it is shown, that the solution of the functional equation is reduced to the solution of a singular integral equation with respect to the deformation of intermediate finite segment between the stringers, with kernel consisting of singular and regular parts, the solution of which is reduced to the solution of a quasi-regular infinite system of linear algebraic equations.

On a contact problem for an elastic composite infinite plate with two finite elastic stringers

In the present paper a contact problem is considered for elastic composite (piecewise-homogeneous) infinite plate, consisting of two semi-infinite plates with different elastic properties, attached to each other along common straight bound, strengthened with two finite elastic stringers, which are on different sides of the heterogeneity line of the mentioned semi-infinite plates and welded (glued) to those semi-infinite plates. It is assumed, that one of the stringer is parallel, the other is perpendicular to the heterogeneity line of the semi-infinite plates, have different elastic properties and cross-sectional areas. The contacting pair (plate-stringer) is deformed by concentrated forces applied on the stringer’s bounds. The problem is formulated as a system of singular integral equations under some conditions, the kernels of which are consisted from singular and regular parts. Then, that system is solved by means of well-known mathematical method of Chebishev orthogonal polynomials, which reduces the system of integral equations to a regular infinite system of linear algebraic equations. Formulas for determining normal stresses in finite elastic stringers are obtained.

Research of dynamic processes on the basis of the analysis of dynamics of the single speckle

In work application single speckles for research of dynamic normal displacements of elements of constructions is considered. The optical scheme for realization of the offered method of
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To the problem of plate vibration in the longitudinal magnetic field
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Tribological investigation of asbestos-free friction materials

It is shown that the functionality of frictional braking materials in the conditions of high-temperature friction is determined by the stress-strain state of contacting thin surface layers where acting tension and compressive stresses which exceeding the limit of strength at shearing. It is also denoted that properties of reinforcing filling materials have a significant importance. The results of tribological investigation of new asbestos-free friction materials are reduced.

The Investigation of longitudinal waves propagation in electroconductive plates at the presence of longitudinal magnetic field

With the help of equations obtained on the basis of refinements of electromagnetic part of magnetoelasticity hypothesis of thin bodies the propagation of longitudinal waves in electroconductive plates in longitudinal magnetic field is investigated. Asymptotic expansion of the unknown quantity is carried out for weak and strong conductive plates.

On a problem of stability of compressed rectangular plate

The problem of stability of the perturbed motion of a plate loaded "follower" force, in the presence of concentrated inertial mass is investigated. It is shown that when the other three edges of the plate are hinged, there is a divergent instability. And when the two opposite edges hinged, and the third - is clamped, then the divergent instability does not exist. A special case of this problem is the task of Bolotin, who were the first calculated the critical force for stability of a flexible rod clamped at one end and loaded at the other end of the tangential compressive force. Problem of stability of elastic system loaded with follower forces, first explored E.L.Nikolai. Nikolai, Bolotin and Beck are known for their problems of stainability of the rod, loaded follower forces.

Research of the stress state near two cracks, which begin of one point, under the longitudinal shear wave interaction.

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Anti-plane vibrations of the multilayered piezoelectric medium free from defects at the interface between layers

The work studies a problem about shear vibrations of the multilayered piezoelectric medium. The formulae for calculating basic dynamic characteristics of the problem have been obtained taking into account the cohesiveness of electrical and mechanical fields.

Equations of thermodynamic orthogonality in non-linear hyperbolic thermoelasticity

The present study is devoted to formulations of constitutive equations for the non-linear Green–Naghdi type-III thermoelastic continuum consistent with the principle of thermodynamic (or thermomechanical) orthogonality. The principle of thermodynamic orthogonality proposed by Ziegler as a generalization of the Onsager linear irreversible thermodynamics states that the irreversible constituent parts of thermodynamic currents (velocities) are orthogonal to the convex dissipation potential level surface in the space of thermodynamic forces for any process of heat transport in a solid. The principle of the thermomechanical orthogonality takes its origin from the von Mises maximum principle of the perfect plasticity, where it provides existence of a
yield surface, its convexity, and the associated flow rule. Non-linear constitutive laws of heat propagation as of type-III thermoelasticity complying with the principle of thermomechanical orthogonality are discussed. Important for applied thermoelasticity cases covered by type-III theory are studied: GNI/CTE – conventional thermoelasticity based on the Fourier heat conduction law and GNII – dissipationless hyperbolic thermoelasticity. In the latter case the internal entropy production equals zero for any heat transport process having the form of the undamped thermoelastic wave propagating at finite speed.

**Radchenko A. V., Radchenko P. A.**

*Influence of orientation of the vector of velocity of the striker on destruction of the anisotropic barrier at high- velocity interaction*

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**Sahakyan A.V.**

*The solution of a contact problem with slipping and adhesion zones (Galin’s problem) by the method of discrete singularities*

In this work the contact problem of an indentation of a flat punch into an elastic half-plane, when the contact region is divided into slipping and adhesion zones, is considered. A solution of this problem is reduced to a system of three singular integral equations respect normal and tangential stresses in the adhesion zone and contact pressure in the slipping zones. The solution of this system is built by the direct numerical integration with method of discrete singularities. Numerical analysis is shown a convergence of the computational process in dependence of degree of interpolation formulas. The graphs of contact stresses distribution is plotted. Dependence of a length of adhesion zone on a friction coefficient and Poisson ratio is investigated.

**Sargsyan A.M.**

*On the influence of the boundary conditions type on the arc part of the circular sector contour on the behaviour of the stresses in the conditions of smooth contact on the radial sides*

An elastic equilibrium of a thin circular sector with unit radius and arbitrary angle of opening $\alpha$, when on the arc part of the contour normal displacement and tangential stress are given, and on the radial sides the conditions of smooth contact takes place, is studied. A closed solution of the problem is obtained with the help of the method of variables separation. It was shown that in both cases, when the angle of the wedge tends to $\pi$ or $2\pi$, the stresses have degree characteristics of $r^{-1+\varepsilon}$ ($\varepsilon \to +0$) type, and the coefficients with such singularity in the conditions of general loading of the boundary arc part in the first problem are different from zero and in the second problem tend to zero. Here another case of loading of the arc part of the boundary sector is being analyzed.

**Sargsyan A. H.**

*Natural vibrations of round plates based on the micropolar theory with independent fields of transitions and rotations*

In this paper on the basis of general theories of micropolar dynamic thin elastic plates with independent fields of transitions and rotations free vibrations of hinged-simply supported round plates are studied. Determination of natural frequencies is reduced to the solution of
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Limiting transition from local loading to concentrated force in expression for the gradient of deflection of the simply supported rectangular plate

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with a stamp. The base of the stamp is rectangular, parabola, cylinder or sphere according to the system of coordinates. In the contact area for some problems are normal and shear stresses can be related to Coulomb's law. Normal and shear stress act on the stamp, stamp-base system is in terms of limiting equilibrium, for some problems on the stamp only normal load is applied. Through programs of analytical calculations are obtained integral equations of the first kind whose kernels are presented in explicit analytic form. The main properties of the kernels of integral equations are studied. It is shown that the numerator and denominator of the kernels symbols can be represented as a polynomial relatively the shear modules of the layers and space. The coefficients of these polynomials contain exponential and power function of the relative layers thicknesses and Poisson's ratio. Efficient schemes for solution of integral equations are proposed. The contact stresses, the size of the contact area, the relationship moving stamp and forces acting on it are calculated.

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To the problem of calculation of flexible gear wheels of a wave transmission by semi-momentless theory

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On the resonance oscillations of longitudinally vibrating growing rod

The theory of growing structures is a new and fast developing branch of analytical mechanics basing on the theory of partial differential and integral equations. In the present paper the authors analyze qualitative properties of growing rods subjected to longitudinal vibrations. This problem is described it terms of the linear classical, Rayleigh-Love and Rayleigh-Bishop models. It is assumed that the rod is fixed at one end and free at the other end and its length is increasing. For solution of this problem we make a special change of variables which transforms the original equations into new equations with variable coefficients. It is shown that these equations are hyperbolic and possess several interesting and important properties. First of all, the amplitudes of vibration of the rod are growing with time. For example, if the rod length is increasing proportionally to time the amplitudes are also growing proportionally to time. Secondly, if a particular mode is excited it excites other modes. In this case the mechanism of the modes excitation is asymmetric, which means that the low frequency modes possess higher amplitudes compared to the higher frequency modes. The physical explanation of these phenomena is proposed and discussed.
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Creep of cementosoils during compression

The current investigation is devoted to the main questions of the creep of the cementosoil. The object of exploration is clayey bottom soils, which is the main element of the cementosoils, taken from the territories of Araq town of Eqabad region of Islamic Republic of Iran. The soils of different ages - 7, 21, 28, and 60 days old and with 1.68, 1.60, 1.55, 1.50 g/cm³ density of soil skeleton, mixture of 93% of soil and 7% of cement were tested on temporary compressive strength and on parameters of creep. During the test were taken into consideration the role of deformations of shrinkage in the compressive deformations. The creep deformation is taken as the differences between the full deformation and deformation of shrinkage. At the same stress increase of the age initiate decrease of creep deformations because of the rise of the strength during the time at cementosoils of different ages. As a result of the current investigation it has been established that cementosoils of the same age under the conditions of equal relative compressive strength (independent of initial compactness) for the same periods the relative deformations of creep are practically equal to each other.

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Thin-walled tube under radial edge load

This work treats the problem describing the equilibrium of a thin-walled cylindrical non-linearly elastic membrane which is subjected to an outward radial extension applied to one of its ends only. The material of membrane is hyperelastic, isotropic and incompressible. We carefully formulated the geometrically exact equations from the variational principle of minimum potential energy within the framework of nonlinear membrane theory. For Bartenev-Khazanovich and Chernykh–Shubina strain energy functions the solutions were obtained explicitly. It follows from results that these materials have limit value of stretching which depend on the material constants and the initial radius.

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An analytical approach is used to investigate the existence and propagation behavior of surface electro-elastic Love waves in an ideally layered structure consisting of a functionally graded piezoelectric substrate and a dielectric layer. The piezoelectric substrate is polarized in the direction perpendicular to the wave propagation plane and its material parameters change continuously along the thickness direction. The dispersion equations for the existence of surface Love waves with respect to phase velocity are obtained for electrically open and shorted cases, respectively. A detailed investigation of the effects of material gradient on dispersion curve, phase velocity, group velocity, and electromechanical coupling factor is carried out. Numerical results show that material gradient significantly affects the fundamental mode of Love waves but has only negligible effects on the high order modes. Large electromechanical coupling factors could be achieved by an appropriate adjustment of gradient coefficients, which is of practical interest for designing acoustic wave devices.

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The question of existence of Stoneley surface wave in a three-dimensional formulation is considered. At the interface between two half-spaces are given conditions for the continuity of two displacements, the normal stress, a shear stress and the restriction of the third displacement. Characteristic equation for the phase speed of surface waves is obtained. The special cases are considered

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Study of the dependence of effective compliances of a plane with an array of round holes on array parameters

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Regular structure materials are used in different technological processes. Therefore, investigation of the mechanical properties of these materials is of considerable practical interest. These mechanical properties are represented by the relationship between average stresses and effective strains, which can be obtained from the solution of the problem for elastic plane. In this paper, we employ the model of an elastic plane having a biaxial periodic system of round holes to analyze the dependence of the effective elastic parameters on the direction of applied loads and the geometrical characteristics of the system. Parameters anisotropy is demonstrated. The abnormally high values of Poisson’s ratio, which are impossible in isotropic media but observed in some anisotropic media, are found.

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Distribution of energy storage rate in area of plastic strain localization during tension

The presented work is devoted to the new method of energy storage rate determination that allows to obtain distribution of this quantity on the surface of deformed specimen. The method is based on the experimental procedure for simultaneous measurements of temperature, and displacement distributions on the surface of tested specimen during tensile deformation. This procedure involves two complementary imaging techniques: CCD technique and infrared thermography (IRT). It has been shown experimentally that during evolution of plastic strain localization the energy storage rate in some zones of deformed specimen drops to zero end even to negative values. To interpret this result in terms of micro-mechanisms, microstructural observations using electron back scattered diffraction (EBSC) and transmission electron microscopy (TEM) were performed on specimens in different states of deformation.

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Dynamic fracture and pulsed strength of continuum

Some of the principal features of the behavior of materials subjected to impact actions are common for a number of seemingly quite different physical processes, such as dynamic fracture (starting cracks and spalling), cavitation in liquids, and electrical breakdown in solids. The examples of different physical processes considered in the paper show the fundamental importance of investigating incubation processes preparing abrupt structural changes (fracture, yielding and phase transitions) in continua under intense pulsed actions.

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Wave propagation in piezoelectric waveguides with periodic interface conditions

The propagation of electro-magneto-elastic coupled shear waves in a piezoelectric waveguide is considered within a full system of the Maxwell’s equations. Two different conditions along the guide walls have been studied in the case of periodic electrically shorted interfaces. It has been shown that under electrically shorted periodic transmission conditions the Bloch-Floquet waves exist only at acoustic frequencies. The results demonstrate the significant effect of piezoelectricity on the widths of band gaps at acoustic frequencies.

Radchenko P., Goncharov M., Baldin I., Plevkov V., Radchenko A ........................................ 297

Influence of strengthening on destruction of reinforced concrete elements of designs at dynamic loading

This paper present results of experimental and numerical research of reinforced concrete columns and joints at short-term vertical dynamic loading, which have yielded new results of the stressedly-deformed condition and schemes of fracture.

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Estimation of hydraulic structures safety by comparison of strength and stability theories

Hydraulic structures being structures of first class require meeting the safety operation conditions. To secure safety operation conditions of earthfill dams it is important to evaluate their coefficients of stability and strength factor by calculation of mode of deformation of dam body. To complete these calculations the dam body soil actual state observation has to be carried
out by experiments. Based on experimental data the mode of deformation of dam body is revealed by software modeling investigations, and safety operation conditions are evaluated. The mode of deformation is defined by nonlinear equations, which specify elasto-plastic state of dam body soil. Hydraulic structures safety and stability evaluation methods are elaborated in case of dynamic impact.

Seyranian A.P., Mailybaev A.A.  
Paradox of Nicolai and similar effects in stability problems

We present a general approach to the paradox of Nicolai and similar effects analyzed as a singularity of the stability boundary. We study potential systems with arbitrary degrees of freedom and two coincident eigenfrequencies disturbed by small non-conservative positional and damping forces. The instability region is obtained in the form of a cone having a finite discontinuous increase in the general case when arbitrarily small damping is introduced. This is a new destabilization phenomenon, which is similar to the effect of the discontinuous increase of the combination resonance region due to addition of infinitesimal damping. Then we reconsider the paradox of Nicolai: the instability of a uniform axisymmetric elastic column loaded by an axial force and a tangential torque. It is shown that the paradox of Nicolai is related to the conical singularity of the stability boundary which transforms to a hyperboloid with the addition of small dissipation.

Shekyan L., Verlinski S., Shekyan A., Aidun D., Marzocca P.  
Elasto-hydro-dynamic friction of a circular cylinder and of a cylindrical bush with elliptical cross-section

The framework of elasto-hydro-dynamic lubrication theory [1] is discussed in this paper. The theoretical plane contact problem of a liquid friction rotating about a cylindrical axis with a fixed non-deformable elastic cylindrical bush is presented. An elliptical ring cross-sectional shape is considered for the bush. The particular case of plane contact problem, when the interaction of these bodies is in the boundary lubrication regime was discussed in [2]. The problem is reduced to a closed system of nonlinear integral equations. A complete mathematical analysis of this system is carried out on the principle of contracting mappings developed in [3] and a numerical analysis is used in the design of sliding bearings.

Sumbatyan M.A., Ciarletta M., Zampoli V., Vaccaro M.  
Protection of the elastic rectangular structure from seismically generated oscillations by a viscoelastic stratum

We study the problem about harmonic oscillations of the elastic structure of rectangular shape upon a foundation, in the case when oscillations are caused by a seismic wave arriving from below. The structure is placed on the elastic half-space. In order to protect the structure from the incoming seismic waves, there is applied a special isolation from vibrations by some damping media modeled by a classical viscoelastic material of Kelvin-Voigt type.

Valesyan S. Sh.  
Investigation of the influence of ageing on the dissipative properties of getinacks subjected to repeated static loading

The effect of ageing on the dissipative properties of getinacks subjected to repeated static loading has been investigated. Specimens were tested at the age of 1, 4, and 8 years. The approximation of experimental data is done, and the energy of dissipation is calculated. The hysteresis characteristics have been obtained at the values of strength close to the values of its ultimate strength. Based on the investigation of getinacks manufactured by the technology of regulated thermo-pressing, this technology can be recommended for the manufacturing of appropriate products.

Vashakmadze T. S., Gvinchidze G. I.  
To survey of some results from Zavriev in the viscous-elasticity
In the first part we give the generalized form for kernels when the mathematical models for
elasto-creeping materials are linear and homogeneous. The foundations of these results are some
achievements gathered by groups of engineers and mathematicians from Zavriev Institute of SM
& EE and Vekua IAM in the period 1968-2005 from great influences of Arutiunian’s heritage.
In the second part we present the method of constructing 2Dim with respect to spatial
depends on the natural dynamical for a mathematical models of von Kármán-Reissner-Mindlin
type for viscous -elastic thin-walled structures and corresponding governing relations without
any simplify hypothesis of mechanical or geometrical meanings and Volterra’s principle.

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The problem of intraocular pressure measurement modeling by a pneumotonometric method

The procedure of measuring the intraocular pressure by an optical analyzer is numerically
simulated. The cornea and the sclera are considered as axisymmetrically deformable shells of
revolution with fixed boundaries; the space between these shells is filled with incompressible
fluid. Nonlinear shell theory is used to describe the stressed and strained state of the cornea and
sclera. The optical system is calculated from the viewpoint of the geometrical optics.

Dependences between the pressure in the air jet and the area of the surface reflecting the light
into a photodetector are obtained. The shapes of the regions on the cornea surface are found
from which the reflected light falls on the photodetector. First, the light is reflected from the
center of the cornea, but then, as the cornea deforms, the light is reflected from its periphery.
The numerical results make it possible to better interpret the measurement data. Two types of
boundary conditions are compared; for each of them, the relation between the pressure in the air
jet and the area of the surface from which the reflected light is recorded by the photodetector is
analyzed.